

## Patent Claims

1. Planar optical waveguide comprising  
a core region and  
a cladding region comprising a photonic crystal material,  
said photonic crystal material having a lattice of column elements; wherein at least a  
number of said column elements are elongated substantially in an axial direction for said  
core region.
2. Planar optical waveguide according to claim 1, characterized in that said  
core region at least partly is in the form of a defect in said lattice of the photonic crystal  
material.
3. Planar optical waveguide according to claim 1 or 2, characterized in that  
said core region comprises a material having a low effective index of refraction and that  
said cladding region involves a higher effective index of refraction.
4. Planar optical waveguide according to claim 3, characterized in that said  
cladding region comprises a background material having a first refractive index ( $n_1$ ), that  
said column elements comprise a material having a second refractive index ( $n_2$ ), and that  
said second refractive index ( $n_2$ ) is higher than said first refractive index ( $n_1$ ).
5. Planar optical waveguide according to claim 3, characterized in that said  
cladding region comprises a background material having a first refractive index ( $n_1$ ), that  
said column elements comprise a material having a second refractive index ( $n_2$ ), and that  
said second refractive index ( $n_2$ ) is lower than said first refractive index ( $n_1$ ).
6. Planar optical waveguide according to claim 4 or 5, characterized in that an  
effective refractive ratio for said cladding region, e.g. a ratio between said second

refractive index ( $n_2$ ) for said column element(s) and said first refractive index ( $n_1$ ) for said background material, is defined and that said ratio is less than 2.0.

7. Planar optical waveguide according to claim 6, characterized in that said effective refractive ratio for said cladding region is less than 1.5, in a more preferred form less than 1.3, in a still more preferred form less than 1.2 and in a still further preferred form less than 1.1.

8. Planar optical waveguide according to claim 6 or 7, characterized in that said effective refractive ratio for said cladding region is less than 1.05, in a more preferred form less than 1.04, in a still more preferred form less than 1.03, and in a still further preferred form less than 1.02.

9. Planar optical waveguide according to one or more of claims 1 - 8, characterized in that said core region comprises a material identical to or similar to a material forming background material of said cladding region.

10. Planar optical waveguide according to one or more of claims 1 - 9, characterized in that said columns elements comprises a material containing impurity elements, e.g. Germanium doped into silica glass.

11. Planar optical waveguide according to one or more of claims 1 - 10, characterized in that said waveguide comprises glass materials, semiconductor materials, and/or polymer materials.

12. Planar optical waveguide according to one or more of claims 1 - 11, characterized in that said cladding region comprises a background material comprising or consisting of  $\text{SiO}_2$  and that said background material has a first refractive index ( $n_1$ ), wherein  $1.4 \leq n_1 \leq 1.5$ , in a more preferred form  $1.43 \leq n_1 \leq 1.47$ , and in a still more preferred form  $1.44 \leq n_1 \leq 1.45$ .

13. Planar optical waveguide according to one or more of claims 1 - 11, characterized in that said cladding region comprises a background material comprising or consisting of Si and that said background material has a first refractive index ( $n_1$ ), wherein  $2.5 \leq n_1 \leq 3.0$ , in a further preferred form  $2.6 \leq n_1 \leq 2.9$ , and in a still further preferred form  $2.7 \leq n_1 \leq 2.8$ .

14. Planar optical waveguide according to one or more of claims 1 - 11, characterized in that said cladding region comprises a background material comprising or consisting of a Group III-V material and that said background material has a first refractive index ( $n_1$ ), wherein  $3.0 \leq n_1 \leq 4.5$ , in a further preferred form  $3.3 \leq n_1 \leq 4.3$ , and in a still further preferred form  $3.7 \leq n_1 \leq 4.0$ .

15. Planar optical waveguide according to one or more of claims 1 - 14, characterized in that said column elements comprise a material comprising or consisting of  $\text{SiO}_2$  and that said material has a second refractive index ( $n_2$ ), wherein  $1.0 \leq n_2 \leq 1.5$ , in a preferred form  $1.4 \leq n_2 \leq 1.5$ , in another preferred form  $1.43 \leq n_2 \leq 1.47$ , and in a still further preferred form  $1.44 \leq n_2 \leq 1.45$ .

16. Planar optical waveguide according to one or more of claims 1 - 14, characterized in that said column elements comprise a material comprising or consisting of Si and that said material has a second refractive index ( $n_2$ ), wherein  $1.0 \leq n_2 \leq 3.0$ , in a preferred form  $2.5 \leq n_2 \leq 3.0$ , in another preferred form  $2.6 \leq n_2 \leq 2.9$ , and in a still further preferred form  $2.7 \leq n_2 \leq 2.9$ .

17. Planar optical waveguide according to one or more of claims 1 - 14, characterized in that said column elements comprise a material comprising or consisting of a Group III-V material and that said material has a second refractive index

( $n_2$ ), wherein  $1.0 \leq n_2 \leq 4.5$ , in a preferred form  $3.0 \leq n_2 \leq 4.5$ , in another preferred form  $3.3 \leq n_2 \leq 4.3$ , and in a still further preferred form  $3.7 \leq n_2 \leq 4.0$ .

18. Planar optical waveguide according to one or more of claims 1 - 17, characterized in that said lattice of column elements comprises a lattice constant ( $\Lambda$ ), that a normalized wavelength  $\lambda/\Lambda$  is defined by means of said lattice constant ( $\Lambda$ ) and a wavelength ( $\lambda$ ) for optical waves propagated by the waveguide and that said cladding region comprises a background material comprising or consisting of  $\text{SiO}_2$ , wherein  $\Lambda/\lambda < 1.0$ , in a further preferred form  $0.1 < \Lambda/\lambda < 0.8$ , and in a still further preferred form  $0.2 < \Lambda/\lambda < 0.5$ .

19. Planar optical waveguide according to one or more of claims 1 - 17, characterized in that said lattice of column elements comprises a lattice constant ( $\Lambda$ ), that a normalized wavelength  $\lambda/\Lambda$  is defined by means of said lattice constant ( $\Lambda$ ) and a wavelength ( $\lambda$ ) for optical waves propagated by the waveguide and that said cladding region comprises a background material comprising or consisting of Si wherein  $\Lambda/\lambda < 2.0$  and in a further preferred form  $\Lambda/\lambda < 1.5$ .

20. Planar optical waveguide according to one or more of claims 1 - 17, characterized in that said lattice of column elements comprises a lattice constant ( $\Lambda$ ), that a normalized wavelength  $\lambda/\Lambda$  is defined by means of said lattice constant ( $\Lambda$ ) and a wavelength ( $\lambda$ ) for optical waves propagated by the waveguide and that said cladding region comprises a background material comprising or consisting of a Group III-V material, wherein  $\Lambda/\lambda < 3.0$ .

21. Planar optical waveguide according to one or more of claims 1 - 20, characterized in that said cladding region comprises a background material

having a first refractive index ( $n_1$ ), and that an effective guided mode index is lower than said first refractive index ( $n_1$ ).

22. Planar optical waveguide according to one or more of claims 1 - 21, characterized in that said column elements comprise a material having a second refractive index ( $n_2$ ), and that an effective guided mode index is lower than said second refractive index ( $n_2$ ).

23. Optical device comprising a planar optical device according to one or more of claims 1 - 22.

24. Optical device comprising an optical amplifier further comprising a planar optical device according to one or more of claims 1 - 22.

25. Optical device comprising a laser further comprising a planar optical device according to one or more of claims 1 - 22.

26. Optical device comprising an optical filter further comprising a planar optical device according to one or more of claims 1 - 22.

27. Optical device comprising an add-drop multiplexer further comprising a planar optical device according to one or more of claims 1 - 22.

28. Optical device comprising an optical splitter further comprising a planar optical device according to one or more of claims 1 - 22.

29. Optical device comprising a wavelength converter further comprising a planar optical device according to one or more of claims 1 - 22.

30. Optical device comprising means for performing an optical switching, a controllable coupling or a transferal of optical waves said optical device further comprising a planar optical device according to one or more of claims 1 – 22.

31. Optical device according to claim 30, c h a r a c t e r i z e d i n that said means for performing an optical switching, a controllable coupling or a transferal of optical waves comprise a movable coupling element (33, 43).

32. Optical device according to claim 31, c h a r a c t e r i z e d i n that the device comprises means for actuating said movable coupling element (33, 43).

33. Optical device according to claim 32, c h a r a c t e r i z e d i n that said means for actuating said movable coupling element (33, 43) involve the use of mechanical means, means sensitive to heating and/or cooling, means sensitive to pressure and/or means sensitive to electromagnetic fields etc.

34. Optical device according to one or more of claims 30 - 33, c h a r a c t e r i z e d i n that said device comprises micro-flow means associated with said optical switching, controllable coupling or transferal of optical waves.

35. Optical device according to claim 34, c h a r a c t e r i z e d i n that said micro-flow means involves utilization of a fluid, in particular two or more fluid elements having different refractive indices.

36. Optical device according to claim 35, c h a r a c t e r i z e d i n that said two or more fluid elements comprised in said micro-flow system are separated by mechanical means or preferably that said two or more fluid elements are non-mixable fluid elements or essentially non-mixable fluid elements

37. Method of making a planar optical waveguide, in particular a planar optical waveguide according to one or more of claims 1 – 22, comprising steps involving multi-layer depositing and/or processing.

38. Method according to claim 37, c h a r a c t e r i z e d i n that said steps comprise depositing, etching and/or lithographic processes.

39. Method of making a planar optical waveguide, in particular a planar optical waveguide according to one or more of claims 1 – 22, comprising steps involving laser induced refractive index changes.

40. Method of making a planar optical waveguide, in particular a planar optical waveguide according to one or more of claims 1 – 22, comprising steps involving self-writing waveguides.

41. Method of making a planar optical waveguide, in particular a planar optical waveguide according to one or more of claims 1 – 22, comprising steps involving ion implantation.